Some Obſervations
Concerning the Baroſcope and Thermoſcope, made and communicated by Doctor I. Wallis *at* Oxford, *and Dr.* I Beale *at* Yeovil *in* Somerſet, *deliver'd here according to the ſeveral* dates, *when they were imparted.*

Dr. Beale *in thoſe Letters of his dated* Decemb.18. *Decemb. 29. 1669. and Januar. 3. 16*$\frac{69}{70}$.

HAving not look'd upon my Barometer a long time, I did by meer chance caſt my Eye on it upon Munday laſt, *Decem.* 13. *1669.* about one of the Clock p. m.; and juſt then I ſaw the Quickſilver higher, than I dare poſitively affirme that it was ever ſince I had it in my cuſtody, *viz.* ſince *May* 28, *1664.* It was compleatly and apparently above half an inch more than thirty inches high. I called younger men to examine it over and over very carefully, by a meaſure, taken exactly from the ſtandard-foot of *London*, both in Braſs and in Box. They meaſured it often from that time, which was Munday, and late in the night of that day; then on Tueſday morning early; oft-times in the day, and late at Night: alſo ſome part of Wedneſday. In all which time, when it was loweſt, it was (as I ſaid at firſt) compleatly 30½ inches; ſometimes manifeſtly higher to the eigth or tenth part of a inch.

For this Baroſcope I have two Glaſs-canes in one veſſel of ſtagnant Quickſilver. They are of equal length, not fully two inches higher, than the Mercury aſcended, and no Bolt-head to either of the Glaſſes. The one hath not been moved theſe two or three years, and hath a tincture of the Mercury on the empty top, as from the ſteams of the Mercury in ſome hot Summer; the other Glaſs was placed there about a year and an half agoe. This hath no tincture on the top. Both agreed in this Indication, as others affirme; but, to my Eye, in the latter Glaſs the Quickſilver ſeemed to be ſomething higher.

The Weather was at firſt diſcovery very bright and clear; a gentle froſt, by the Suns heat melting. The Air was very ſilent, no wind ſtirring, and the curious Wind-vane noting, that the wind was directly in the *Eaſt* all the firſt day (*Decemb.* 13;)

on

on *Decem.* 14. the wind had a ſhort ſwing from the *North-weſt*, and haſtened again toward the *Eaſt*, yet ſo as to be *North-Eaſt.* During this agitation, or change or Winds, the Mercury deſcended a little; and after, upon the reſetling of the wind, the Mercury aſcended a little higher, than it had been the day before.

My Houſe and Study, where I keep this Baroſcope, is on the ſide of an Hill; on the higher ſide of this Country, as I gueſs near a level with the Head of a River; which River, running ſlowly. and falling into the *Severne*-ſea about 20. or 30. miles Weſt-ward of *Briſtol*, we cannot be very much above the level of the Sea.

My Thermoſcope, ſtanding cloſe by my ſaid Barometer, was at the juſt hight of ordinary diſſolving Weather. In the following dayes it was colder. Whether the late Summer-drought, or what elſe, might incline this Winter-air to have more than ordinary Weight, or a ſtronger Spring, I muſt refer to the conſideration of the more skilful. And if you pleaſe to give notice for a general Obſervation, what Springs do now moſt fayle, or more abound in any Vertue, Quality, or Quantity, it may probably be inſtructive for divers inferences; and particularly, it may give ſome degree of indication, Whether the Springs proceed from the fall of Rain, or by Subterraneous paſſages from the Seas, or by change of Air into Water.

But to returne to my Thermometer, I ſhall give you further notice, that on *Decemb.* 26. 1669. in the Morning, the Weather was colder than ever I found it, ſince I could take it by the meaſure of a Thermometer, that is, ſince theſe 5. or 6. years. It was very cold and frezing quick ſome dayes before, and ever ſince: And yet in this time the Mercury hath ſometimes faln more than an Inch, without any other change of Weather, than ſome guſts of wind, ſome ſprinklings of Snow * at ſeveral times, in all, ſcarce enough to cover the ground; and ſome abatements of Cold more eſpecially when the Sun was up.

* *This was written before the great Snow fell.*

I have examined my *Ephemeris* from May 28. 1664. till now: In all which time I find it not remark'd for any ſuch de-

gree

gree of Cold, as hath been, ſince *Chriſtmas* began, and continues every Night and Morning to this very day of *Decemb.* 29; though the extremeſt was, as hath been ſaid, on *Decemb.* 26. To note this degree of Cold more particularly, I muſt acquaint you, that in my ſtanch Thermometer on the ſaid 26 of *December*, the Liquor was at *three* inches and an *half*. This morning (*Decemb.* 29.) and one or two other mornings it was at *three* inches and *three quarters*. Moſt other times of theſe Cold days, Morning and Evening, it was at the height of *four* inches, in ordinary Briſk Froſts it is at *ſeven* inches. Yet here I muſt obſerve, that ſometimes the Froſt diſſolves, when it is at the 7th figure, and ſometimes I find it at the 8th figure in a ſmart froſt: Whether the Winds, which come not to the Thermometer, may cauſe this difference, or what elſe, I know not. But to proceed, 'tis warm *May*-weather, when 'tis at the 10th figure, and 'tis not much above the 12th figure in the hotteſt weather of *June*, *July*, and *Auguſt*. To compare with former Winters, the loweſt mark is upon *Decemb.* 17. 1665; and then it was at the height of *five* inches and an *half*. And in *Decemb.* 31. 1666, it was about the ſame height; and there I find theſe words; *Very cold, above all of this year, hitherto.* Neither do I find any note ſo low, till this preſent, which is conſiderably lower.

I think it remarkable, that the 7th Inch, and ſometimes the 8th in my Thermometer ſhould abide Freezing, and the Froſt increaſe, till the Liquor deſcended 4½ inches; and yet, that it ſhould not aſcend from the 8th inch more, than 4½ inches in our hotteſt Summer, being hung in the ſame place within 18 inches of the Glaſs-window, facing the *North-weſt*, and in a little Writing-room, in the ſecond row of Buildings. But now I am ſtrongly perſwaded, that the degrees of Heat and Cold are not exactly indicated by the incloſed *Spirit of Wine*: For, when the Snow melted, and the Froſt was firſt diſſolved without Sunſhine, the Liquor was not above the height of *five* inches and an *half*. Poſſibly it retains ſome part of the Cold a while after the ambient Air becomes more tepid.

So farr Dr. Beale. What Dr. Wallis *was pleaſed to impart on this Subject, was written* January 7. 17^{69}_{70}, *at* Oxford, *as follows.*

Concerning my Thermoſcope and Baroſcope (the former of which is known to give accompt of the Temper of the Air, as to *Heat* and *Cold*; the other, of its *Weight*;) I have ſome few particulars to add to the Obſervations, I ſent you ſome years agoe.

The *firſt* is, that, whereas I did then obſerve, that in Hot weather the Quick-ſilver in the Baroſcope did uſe to riſe obſervably, eſpecially in Sun-ſhine and the Heat of the day; which might *ſeem* to argue the Air to be thereby made heavier, (which *I* find was the caſe of ſome other Baroſcopes as well as of mine, and put us to ſome thoughts concerning the reaſon of it;) I do now find (having kept the ſame Barometer, for the ſpace of five years, unalter'd,) the caſe, for theſe two years laſt paſt, to be ſomewhat otherwiſe: And that in hot Sun-ſhiny weather the Quick-ſilver doth rather ſubſide a little; and in extreme Cold and Froſty weather it riſeth.

Which maketh me Judge the Cauſe of theſe contrary Obſervations to be this, *viz.* That the Quick-ſilver, at its firſt putting into the Tube or Baroſcope, was not ſo perfectly cleans'd from Air, but that ſome ſmall quantity of it did remain, undiſcern'd, in the Quick-ſilver: Which latent particles of Air, though ſo ſmall as not to be at all diſcernable to the eye by bubbles, yet by the external heat (adding new ſtrength, as it uſeth to do, to its Elaſtick or Springy power) were ſo much expanded as to give ſomewhat a greater bulk to the ſame quantity of Quick-ſilver, with which it was mingled, and conſequently to make it riſe ſomewhat higher, as being *ſpecifically* lighter (that is, having the ſame weight in a larger dimenſion, or, in the ſame dimenſions, a leſſer weight;) and, upon the receſs of the external heat, the Spring again ſlackening, the Air, being more compreſs'd, ſuffer'd the Quick-ſilver to be again contracted into its former leſſer Dimenſions, and ſo to become heavier, and not to riſe ſo high as before, when it was hotter. But now, the Quick-ſilver, having continued in the Tube for five years and upwards, hath by its own weight cleanſed it ſelf better from that little Air that was in it; and that Air, freed from its entanglement with the Quick-ſilver, being got up into the void part of the Tube above the Quick-ſilver, doth act contrary-wiſe, that is, when it is by Heat (upon the ſtrengthening of its Spring) expanded, it preſſeth down-ward upon the Quick-ſilver, and doth a little depreſs it; and, on the contrary, when by Froſt or very Cold weather this Air (by the abatement of its Spring) is contracted, the Quick-ſilver, freed from that preſſure, riſeth a little. But the Riſing and Sinking on this accompt, (as well that formerly, when this Air was in the Quick-ſilver, as that now, when it is gotten above it,) is not very conſiderable; hardly exceeding the twelfth part of an inch, or thereabout.

This Accompt I thought not amiſs to give you, becauſe it may poſſibly keep your ſelf, or ſome others who make uſe of Baroſcopes, from being impos'd upon by ſuch Obſervations; as if the Sun-ſhining or Heat of the weather did make the Air heavier than before; whereas it ſeems to be but an *accidental* operation upon that un-obſerv'd Air latent in the Quick-ſilver. And I thought it the more neceſſary to take notice of it, becauſe it is not ſo eaſily diſcover'd, unleſs by keeping the Baroſcope unalter'd for a longer time, than (perhaps) is done by ſome of thoſe, who make uſe of it; and, without which, I had not diſcern'd it my ſelf.

On this occaſion, I ſhall add another Accident, which I lately took notice of. Obſerving in the late hard Froſt, that the Quick-ſilver did not riſe a little, at ſuch time as, by reaſon of the fierce freezing, *I* expected it might; I did ſuſpect (as it prov'd to be,) that a little drop of water, (which was at firſt made uſe of for the cleanſing of the Quick-ſilver from the Air, and which hath ever ſince remain'd on the top of the Quick-ſilver within the Tube,) was frozen faſt to the glaſs, ſo as to ſtop the Quick-ſilver from aſcending: And, to try, whether it were ſo or no, I did a little ſhake the Tube by moving it up and down, ſo as to make the Quick-ſilver undulate. Whereupon I found the frozen drop of Water to keep its place, while the undulating Quick-ſilver did ſeveral times beat againſt it. And,

(which

(which is the thing, for which I mention it) the Noiſe upon theſe knocks was not ſuch a dull noiſe, as Quick-ſilver or other Liquids uſe to make in the open Air, by daſhing againſt Glaſs or Ice, or other ſuch hard Bodies; but ſuch a hard ſmart noiſe, as hard Metals uſe to make by knocking one againſt the other; or, as if this Ice had been ſo knock'd by a ſolid piece of Iron or other Metal of ſuch a bigneſs. Which difference of noiſe from what would have been in the open Air (where the intermediate air muſt firſt have been beat away, before the Quick-ſilver could ſtrike the Ice, and thereby the ſtroke of the liquid body obtunded or broken,) I attribute to that voidneſs of Air, which was between the Ice and the diſtant Quick-ſilver. And I remembred preſently, that the Honourable Mr. *Boyle* had formerly ſhew'd me an Experiment, very like this, upon another occaſion: which made me the readier to take notice of this; and I did it ſeveral dayes ſucceſſively. But when, by applying the heat of a Candle to the ſide of the Glaſs, I had melted this Ice, I found (as I expected) that within a little time the Quick-ſilver was riſen about a ſixteenth part of an Inch above what it was before; which the freezing of the Water had till then hindred it from doing.

My Thermoſcope, or Sealed Weather-glaſs, (which, having no communication with the Open Air, and ſo not being affected with its Weight, gives accompt but of its Heat and Cold;) hath, this laſt Froſt, been much lower than I ever have known it, upon *five* years conſtant Obſervation. Which proceedeth partly from the Extremity of the Cold, more than ordinary; and partly from the incloſed Liquor (being Spirit of Wine, tinged with *Cochineal*,) growing leſs ſpirituous.

It was firſt made in *Decemb.* 1664. In the Months of *January*, and of *February* following, we had very ſmart froſts, more cold than ordinary; when yet the loweſt mark, to which the liquor did ſubſide (in very hard froſts, and very cold wind,) was at inches 12¼: (at which time, 14½ was froſt certain, and ſometimes at 15, and at 15½:) The height in Summer following, 1665, was uſually at 20, 21, 22, or thereabouts; but in ſome few very hot

dayes,

dayes, at 25, 26, 26½; (the whole height of the ſmal Cylindrick glaſs, whoſe cavity was about ⅛ of an inch diameter, being about 20. inches; beſides a ſmall Spherical bowl at the top, of about ¾ of an inch diameter; and a bowl at the bottom, which contained the liquor, of about 2 inches diameter: the ſpace above the liquor being, at the firſt compoſure of it, voyd of Air, ſave what it had out of the liquor, which, being warm at the firſt putting in, fill'd the whole cavity, while the Glaſs was hermetically ſealed.)

The Winter following, the liquor ſeem'd to remain much about the ſame temper as in the next foregoing. For in *December*, *January*, and *February*, we had at 14½ Froſt certain; ſometimes at 15. or higher; and the loweſt, to which it did that winter deſcend, was 12 ¾. The height, in the following Summer, *1666*. was uſually about 19,20,21.; the higheſt of all, at 25.

About the end of *December* 1666, and the beginning of *January* following, it was, in hard froſty weather, at 12, 11, and once at 10½, the weather being very cold, and the liquor (it ſhould ſeem) becoming ſome-what leſs ſpirituous, having evaporated ſome of its more ſubtil parts into the voyd cavity: and it was Froſt certain, that winter, about 13½, (an inch lower than the years before;) ſome-times at 14, or 14½. The uſual height in Summer following, 1667, was about 19, 20, 21, and the higheſt at 24½.

The Winter following; it was ſcarce certain froſt at 13; but yet ſometimes at 14, or a little higher: the loweſt, to which it did deſcend that winter, (being very mild after Chriſt-maſs,) was at 12. And the following Summer, *1668*, uſually about 18, 19, 20; the higheſt of all (the heat of that Summer being but very moderate,) at 22.

The next Winter it was froſt certain, abour 12½; but ſometimes, at 13. or higher: the loweſt of all, at 10¼. And in the Summer following, 1669, the higheſt of all (being but a cool Summer) not much above 20

But now this Chriſtmas, *1669*, though I find it to be froſt certain, about 12¼, and ſometimes at higher than 13; yet hath it come ſome-times lower than 8; and particularly *Decemb*. 26

in the morning, to $7\frac{3}{4}$, and did not all that day come ſo high as 8. inches. Which being ſo much lower, than ever it had been in any of the precedent years of my obſervation, though it may in part be attributed to the diſ-ſpiriting of the liquor, yet principally to the extremity of the Cold.

It hath ever ſince been riſing, (but with ſome deſcent in the night-time,) and was on *January* 1, when the froſt ſeem'd firſt to relent, ſomewhat higher than 9; and is this day, Januar. 7, about $13\frac{1}{2}$. The Baroſcope at 29; but for ſome days before, it was about $28\frac{3}{4}$, (the weather having been windy and rainy;) and ſo it was in the froſt, about *Decemb.* 25, but then continued to riſe till about *Januar.* 2. to $29\frac{3}{8}$; but had been *Decemb.* 13. at $30\frac{1}{8}$; which is the higheſt, I have ever known it in my Baroſcope; $27\frac{7}{8}$ being the loweſt, that I have ever obſerved it in, (Octob. 26. 1665;) the moſt uſual hight being about 29, or ſomewhat higher.

But, though mine have been very rarely, and but very little, above 30, or lower than 28, (reckoning from the ſurface of the ſtagnant Quickſilver;) Yet in other places (according to the difference of Airs) it may by others have been found either higher or lower: and ſo likewiſe, according as the Quick-ſilver, at the firſt filling of the inverted Tube, was more or leſs cleanſed of Air. For, a very little Air, left in the Quick-ſilver, and undiſcernable to the Eye, will, when it gets free of it, and remains in the voyd ſpace above the Quick-ſilver, ſenſibly depreſs the Quick-ſilver: And in the mean time, (before it ſo gets free) will, upon heat of weather, make it ſwell.